1886MNRAS..46..304T

Observation of the Conjunction of Saturn and μ Geminorum, January 10, 1886. By John Tebbutt.

A set of differential measures of *Saturn* and the bright clock-star *μ Geminorum* was obtained here about three hours after the conjunction in Right Ascension on the 10th instant. The position filar micrometer, properly oriented, was employed on the $4\frac{1}{2}$-inch Equatorial, the transit of the planet's first limb and the star being observed across one of the close position-threads, and differences of Declination measured between the star and the planet's south or visible limb. The definition was generally fair, but the southern limb was shaded, and difficult to bring into accurate contact with the declination thread. The images, too, were occasionally rather unsteady. The following table exhibits all the measures obtained. The sidereal times of transit of the limb and the differences of the R.A. of the limb and star have been corrected by the addition of $0^{s}\cdot75$, the time of the semi-diameter passing the meridian, and the differences of Declination by the addition of $9''\cdot2$, the polar semi-diameter.

	Windsor Sidereal Time.			Planet's Centre – Star. Diff. R.A.	Diff. Declin.
	h	m	s	s	″
	4	33	50·83	−2·40	+26·3
	4	37	18·98	−2·25	+28·4
	4	39	44·53	−2·40	+29·9
	4	42	2·33	−2·50	+28·8
	4	44	44·68	−2·60	+28·4
	4	46	9·58	−2·15	+28·3
	4	48	13·83	−2·65	+27·9
	4	50	34·08	−2·70	+28·7
	4	52	58·83	−2·75	+27·8
	4	55	30·53	−2·75	+28·4
	5	6	13·83	−2·90	+29·0
	5	9	29·33	−2·75	+27·3
	5	12	10·08	−2·85	+28·3
	5	16	2·83	−3·00	+29·5
	5	18	29·33	−3·00	+28·5
	5	20	19·83	−2·95	+29·7
	5	22	11·33	−3·15	+29·4
	5	23	41·33	−3·25	+29·9
	5	25	50·03	−3·05	+29·2
	5	27	59·08	−3·25	+29·0
Means	5	1	40·56	−2·77	+28·6
Correction for Parallax				−0·02	−0·9
Adopted App. R.A. and Dec. of Star	6^{h}	16^{m}		5·15	+22° 34′ 5·2
Concluded Geoc. App. R.A. and Dec. of Planet	6	16		2·36	+22 34 32·9

Downloaded from http://mnras.oxfordjournals.org/ by guest on August 21, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System

1886MNRAS..46..304T

The local mean time corresponding to this position is $9^h\ 42^m\ 0^s{\cdot}35$. The planet and star were observed differentially the same evening by means of the 3-inch Transit instrument, the resulting apparent R.A. of the planet's centre being $6^h\ 16^m\ 1^s{\cdot}18$. The evenings preceding and following the conjunction were cloudy. The star during the above observations appeared remarkably red.

Windsor, N.S. Wales:
1886, *January* 19.

On the Connection between Photographic Action, the Brightness of the Luminous Object and the Time of Exposure, as applied to Celestial Photography. By A. C. Ranyard.

The following experiments have been made with commercial dry plates by various makers. My object in the first instance was to obtain a comparison between the sensitiveness of the eye and the sensitiveness of the photographic film, for detecting small differences of illumination. With the eye a difference of one-sixtieth in the intensity of the illumination of two adjacent fields can be detected when the illumination is not too brilliant or too faint, and when the illuminated areas are of sufficient extent.

Fechner has shown that there is a physiological connection between the brightness of the illuminated fields and the difference of illumination which can be detected. He estimated that under the most favourable conditions a difference of one per cent. of illumination could be detected, and from the experiments of Helmholtz and others, there is no doubt that a difference of one-sixtieth can be recognised with certainty.

In order to make such a comparison, successive exposures of equal duration may be made on adjacent parts of the same plate, and the source of light removed through a measured distance between the exposures; or, if a connection can be established between the density of the photographic trace impressed upon the plate and the duration of the exposure, different parts of the plate may be exposed for different periods without moving the source of light, a course which greatly simplifies the experiment.

In order to test in a rough manner whether a light shining on a plate for a unit of time produced the same effect as a light of double the intensity shining for half the unit of time, one-half of a Wratten and Wainwright 'extra sensitive' plate was exposed to the light of a paraffine candle shielded from currents of air at a distance of five feet for a period of forty seconds, and the other half of the plate was exposed to the light of two similar candles for a period of twenty seconds. On developing the two halves of the plate appeared to be of about the same

Downloaded from http://mnras.oxfordjournals.org/ by guest on August 21, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System

1886MNRAS..46..304T

darkness. This experiment was repeated with different modes of development, but whether the developing process was carried so far as to cause the tints to be very dense and opaque, or whether the development was manipulated so as to give faint tints, the two halves of the plate appeared of about the same density.

In order to carry this experiment further, an opaque screen was made, corresponding to the size of the photographic plates experimented with. A quarter of the screen was cut away, so that by placing the screen in front of the plate and turning it round, four successive exposures of areas touching one another could be made upon the same plate.

A Wratten and Wainwright 'extra sensitive' plate was exposed in this manner to the light of a candle, protected from currents of air, so that

the 1st quarter of the plate was exposed for 18 secs. to the candle at a dist. of 2 feet.
,, 2nd ,, ,, ,, exposed for $40\frac{1}{2}$ secs. to the candle at a dist. of 3 feet.
,, 3rd ,, ,, ,, exposed for 72 secs. to the candle at a dist. of 4 feet.
,, 4th ,, ,, ,, exposed for $112\frac{1}{2}$ secs. to the candle at a dist. of 5 feet.

The exposures were made with as great accuracy as possible, the driving clock of my telescope, which can be made to tick at periods of $1\frac{1}{2}$ sec., being used to measure the exposures. On developing the plate, it was found that all four quarters of the plate appeared about equally opaque. It will be noticed that the durations of the exposures are inversely as the square of the distance of the source of light. Several other plates were exposed with longer and shorter periods of exposure, varying inversely as the square of the distance of the candle. The plates were always developed by being entirely immersed in the developing solutions, so that all parts would presumably be equally acted upon. In every instance the four quarters of the plate are so nearly equal in density that it is difficult to decide with certainty which is the darkest.

In one of the longer exposures, where the four quarters of the plate were exposed for 25 minutes, 9 minutes, 4 minutes, and 1 minute, at distances of 15 feet, 9 feet, 6 feet, and 3 feet respectively, there is a slight difference of density, perhaps due to unequal burning of the candle, but the difference is so slight that a friend, to whom I showed this plate, selected the two upper quarters as being less dense than the two lower quarters, and when I removed the plate and turned it upside down, on presenting it to him a second time he again chose the two upper quarters as less dense than the two lower quarters.

These experiments seem to prove that for faint illumination,

Downloaded from http://mnras.oxfordjournals.org/ by guest on August 21, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System

1886MNRAS..46..304T

such as that derived from a candle, the following law of photographic action is either true, or so approximately true, that for all ordinary purposes the deviations from the law, if any, may be neglected.

The photographic trace left upon a plate is directly proportional to the intensity of the light, and to the duration of the exposure.

Having satisfied myself with regard to this law, I proceeded to apply it to testing the sensitiveness of commercial dry plates by various makers to slight differences of illumination. The plates were placed in dark slides and exposed in steps by withdrawing the shutter at intervals of seven and a half seconds, so that a narrow band across the top of the plate was exposed for seven and a half seconds; a band of similar width immediately below it was exposed for fifteen seconds; the band below this was exposed for twenty-two and a half seconds, and so on to the bottom of the plate.

On some of the commoner plates when developed only six steps can be counted. The density of the photographic action increases gradually to the bottom of the plate, but the places where the shutter has stopped cannot be recognised by any sudden change in the density after the sixth step.

I was able to count the greatest number of steps on a Wratten and Wainwright 'extra sensitive' plate exposed to the light of a candle at a distance of 4 feet. On this eighteen steps could be counted with certainty, and possibly nineteen when the plate was examined against a background of clear sky. The following table gives the greatest number of steps which I was able to count on plates by various makers:—

Fry and Son's (Kingston) Dry Plate.

Exposed to the light of a candle at a distance of 4 feet: duration of exposures $7\frac{1}{2}$ s., 15 s., $22\frac{1}{2}$ s., 30 s., &c. 8 steps.

Rouch's (Extra Sensitive) Plate.

Exposed to the light of a candle at a distance of 4 feet: duration of exposures $7\frac{1}{2}$ s., 15 s., $22\frac{1}{2}$ s., 30 s., &c. 8 steps.

Ealing Plate (50 Extra Sensitive).

Exposed to the light of a candle at a distance of 4 feet: duration of exposures 6 s., 12 s., 18 s., 24 s., &c. 9 steps.

Derby Dry Plate Co. (Extra Rapid).

Exposed to the light of a candle at a distance of 5 feet: duration of exposures 9 s., 18 s., 27 s., 36 s., &c. 12 steps.

Downloaded from http://mnras.oxfordjournals.org/ by guest on August 21, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System

1886MNRAS..46..304T

Wratten and Wainwright (Extra Sensitive).

Exposed to the light of a candle at a distance of 4 feet: duration of exposures $7\frac{1}{2}$ s., 15 s., $22\frac{1}{2}$ s., 30 s., &c.
18 (query 19) steps.

Thus the Wratten and Wainwright plate would not register a difference between the illumination given by 20 and 21 candles; and the difference of density of the photographic tint produced by the illumination of 19 and 20 candles was only recognised with difficulty and doubtfully. The photographic plate is therefore much less sensitive than the eye for detecting small differences of illumination. Prof. W. H. Pickering has been making some experiments with American dry plates, and finds that they will not show a difference of less than 5 per cent. of illumination. At first I thought that I could detect the position of the shutter up to some 30 steps, but on examining the plates more closely I found that there was a faint dark line across the plate wherever the shutter stopped. The dark line seemed to be due to reflection of light from the edge of the shutter; but when a little metal shade was made which threw a shadow on the edge of the shutter, as it was drawn up and down the dark line could not be detected, and the utmost number of steps counted was 19.

During a total solar eclipse the corona is not seen till about a minute or at most a minute and a half before totality commences, and observers seem to concur that it dies away in the increasing illumination as rapidly after totality; that is, all trace of the corona is lost when the thickest part of the Sun's crescent is less than a minute across. Taking into account the rapid decrease of light towards the Sun's limb, we shall be much within the truth in estimating that the corona is not seen till the illumination of the atmosphere about the Sun's place is less than one per cent. of the illumination of the atmosphere about the uneclipsed Sun. If the corona becomes visible when the illumination of the atmosphere is reduced to a brightness of thirty times the brightness of the corona, these observations would indicate that the brightness of the illuminated atmosphere round the uneclipsed Sun is at least 3,000 times as great as the brightness of the corona, and that unless the light of the corona is altogether of a different quality from that derived from the uneclipsed Sun, there is no chance of photographing the corona under ordinary daylight conditions. Unfortunately the spectroscopic photographs of the coronal light taken during eclipses, show that the monochromatic light of the corona (though it seems to differ in amount from eclipse to eclipse) never bears any large proportion to the continuous spectrum of the corona, or solar spectrum dispersed by the corona, as it should more properly be called. For the dark lines in the background of continuous spectrum, which recent observers believe that they have identified with certainty with the dark lines of the ordinary solar spectrum, lead to the sup-

Downloaded from http://mnras.oxfordjournals.org/ by guest on August 21, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System

1886MNRAS..46..304T

position that the continuous spectrum of the corona is mainly due to dispersed solar light. If the light is dispersed by particles which are large compared with the wave-length of light, the relative intensity of different parts of the spectrum will not be affected by the dispersion, and there is no chance of photographing the corona under ordinary daylight conditions except by isolating and photographing the monochromatic images which bear so small a proportion to the general light of the corona. There is some evidence, though I do not look upon it as conclusive for all photographic processes, that the position of the maximum of photographic activity in the coronal spectrum does not differ materially from the position of the maximum of photographic activity in the ordinary solar spectrum. The position of the continuous spectrum of the corona relatively to the position of the bright coronal and prominence lines which have been identified in the eclipse photographs shows that the distribution of photographic action in the coronal spectrum does not differ very materially from the distribution of the photographic action in the ordinary solar spectrum.

The Great Shower of Andromedes, 1885. By T. W. Backhouse.

The early part of the shower on November 27, 1885, was well seen at Sunderland. The following table gives the number of meteors actually counted by myself at different times during the display. Column (1) contains the times at which the meteors were counted; (2), the duration in seconds of each counting; (3), the estimated proportion of clear sky in the direction of observation; (4), the number of seconds in column (2) diminished for the extent of cloud; in (5) mention is made of hindrances to visibility of meteors in the portion of sky not clouded; then (6), the number of meteors counted in each interval; (7), the number per minute corrected for the amount of cloud; lastly, in (8), the approximate average direction of the point of sight is designated.

Downloaded from http://mnras.oxfordjournals.org/ by guest on August 21, 2015

© Royal Astronomical Society • Provided by the NASA Astrophysics Data System